RIT-D Final Project Assessment Report

Carlingford Transmission Substation reliability and safety risk mitigation

Endeavour Energy
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Endeavour Energy

Contents

1. Introduction

This Final Project Assessment Report has been prepared by Endeavour Energy in accordance with the requirements of clause 5.17.4 of the National Electricity Rules (NER).

The purpose of report is to demonstrate the basis for selection of the preferred option to address the safety and unserved energy risks created by the deteriorating condition of the control building at Carlingford Transmission Substation.

Carlingford Transmission Substation serves 62,900 customers with a peak demand of 225MVA and an annual energy usage of 990 gigawatt hours.

The need is that the roof of the control building is in poor condition with significant water leaks and a high and increasing risk of complete failure. A roof failure is likely to cause damage to the protection and control systems which is likely to result in an inadvertent trip of the 132kV or 66kV busbars, feeders or transformers, resulting in the loss of supply from the substation for an extended period of time.

A further issue is the presence of asbestos throughout the control building. Although this issue is being managed, the asbestos presents a safety risk to personnel working in and around the building and to the public in the streets around the substation and in the high school which is adjacent the control building.

This report follows publication of a Screening Report that found that a non-network solution is unlikely to form a potential credible option on a standalone basis, or form a significant part of a credible option for Carlingford Transmission Substation. This is due to the magnitude of the load which the substation supplies on a continual basis, the expected cost of network and non-network options and the capacity of the network to facilitate non-network technologies.

Three options were assessed and only two were determined to be credible in addressing the need. The options assessed are listed below:

- Business as usual – Counterfactual;
- Option 1 – Refurbish the existing control building; and
- Option 2 – Replace the control building.

The “Business as usual” (BAU) option is not considered credible as it will result in a significant and growing unserved energy risk as the control building which houses the protection and control systems for the substation deteriorates further in condition. The building also presents a safety risk due to the extensive asbestos contamination.

Option 1 involves the refurbishment of the control building to replace its roof structure and remove the asbestos contamination. This option will remove the safety risks so far as is reasonably practicable (SAFIRP) and reduce the unserved energy risks to the low values expected of a typical transmission substation in good condition.

Option 2 involves the replacement of the control building with a new control and the demolition and removal and rehabilitation of the existing building and site.

The economic assessment of the credible options is shown in Table 1 below. The assessment period for the calculation of present values is 50 years, commensurate with the likely life of a new or refurbished control building, and all values are in real FY22 terms.

The principal benefits are provided by avoided unserved energy (USE) which has been monetised using a value of customer reliability (VCR). The VCR value used in the modelling has been based on the Value of Customer Reliability Report published by the Australian Energy Regulator (AER) in December 2019 and tailored specifically based on the mix of customers supplied by Carlingford Transmission Substation.

A further benefit is the reduction in safety risks due to asbestos contamination which has been monetised using a value of life indexed from published Australian Government figures.

Both options effectively address the safety and unserved energy risks and provide substantial net present value (NPV). However, Option 1 provides the greatest value, at the lowest cost and is therefore the preferred option.

Table 1 – Summary of credible options

Option	Description	Project capex ($M)	PV of benefits (Safety and USE) ($M)	PV of costs ($M)	NPV ($M)	Rank
1	Refurbish existing control building	7.20	101.8	6.87	94.9	1
2	Replace control building	11.3	101.3	10.61	90.7	2

A sensitivity has been undertaken to test alternate sets of key assumptions and the affect they have on the identification of the preferred option. Three alternative future scenarios have been assessed including a central scenario with benefits and costs as estimated as reasonable, a low benefit/high cost boundary scenario and a high benefit/low cost boundary scenario.

The low benefit scenario uses conservative assumptions that give rise to a lower bound NPV estimate for each credible option, in order to represent a conservative future state of the world with respect to potential benefits that could be realised under each credible option.

The high benefit scenario uses an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected potential benefits.

In each scenario considered, Option 1 remained the preferred candidate indicating that there is a high degree of confidence in this result.

Any enquiries regarding this FPR should be directed to Endeavour Energy's Head of Asset Planning and Performance at consultation@endeavourenergy.com.au.

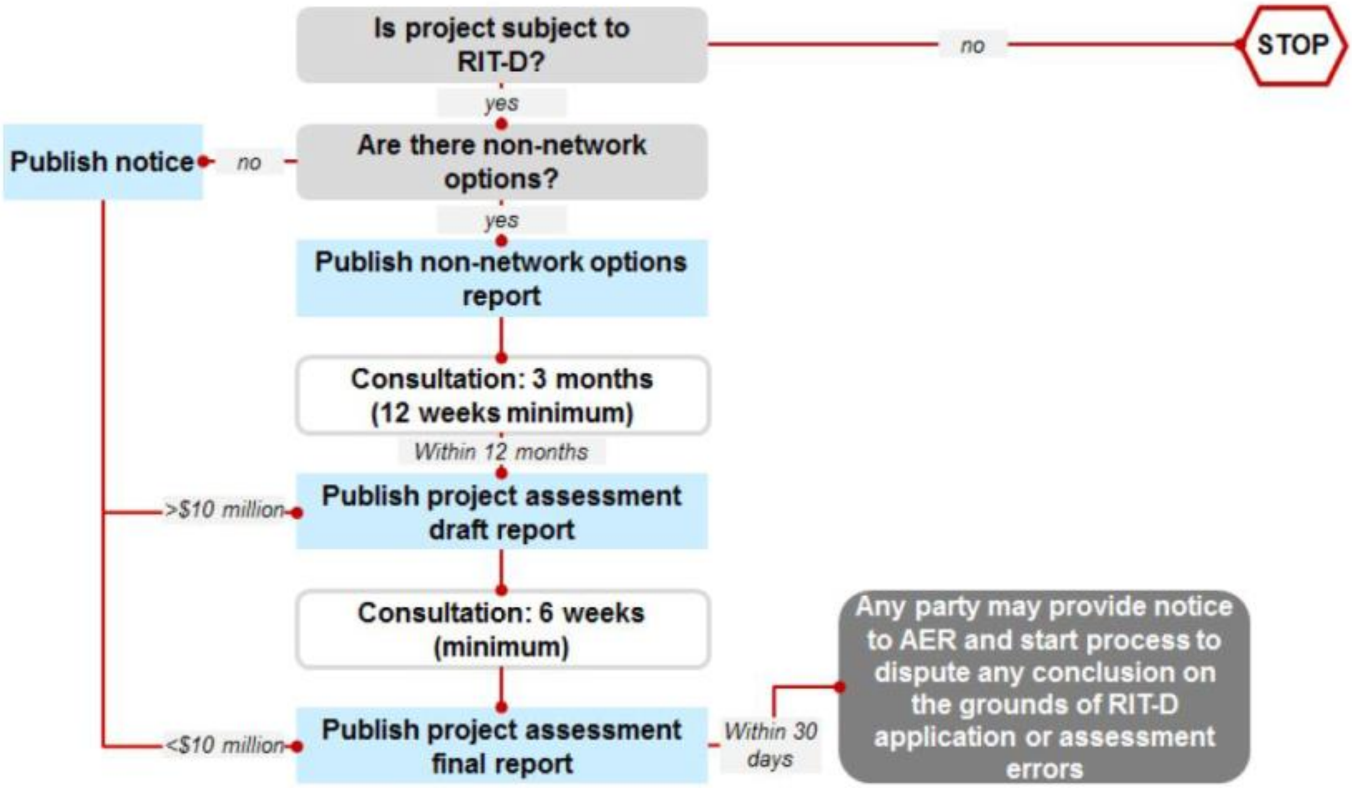
2. RIT-D Process

2.1 Introduction

This FPAR has been prepared by Endeavour Energy in accordance with the requirements of clause 5.17.4 of the National Electricity Rules (NER). This report describes the application of the Regulatory Investment Test – Distribution (RIT-D) for addressing the safety and reliability risks created by the deteriorating condition of the control building at Carlingford Transmission Substation.

Figure 1 below shows the RIT-D process.

Figure 1 - The RIT-D process



2.2 Contact details

Any enquiries regarding this FPAR should be directed to Endeavour Energy's Head of Asset Planning and Performance at consultation@endeavourenergy.com.au.

3. Project background

Endeavour Energy has published a screening report that concludes that non-network options are not feasible for this situation. As a result, non-network options have not been considered in this report.

4. Identified need

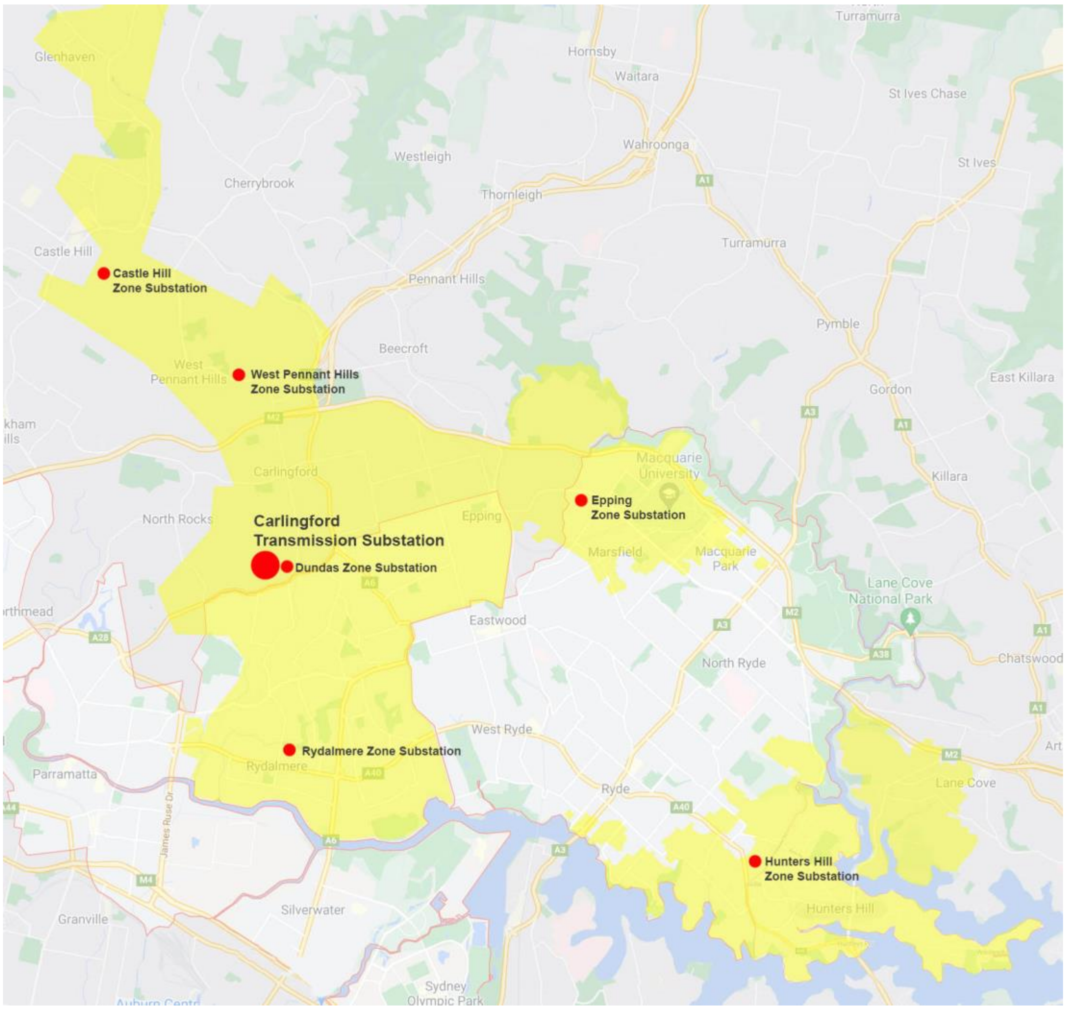
4.1 Existing network overview

Carlingford Transmission Substation is a 132/66kV substation which was originally built by the Electricity Commission of NSW in the early 1950’s and expanded in the mid 1960’s. The substation is situated between new high-rise residential development and James Ruse Agricultural High School.

The substation supplies Endeavour Energy’s Castle Hill, Dundas, Rydalmere and West Pennant Hills zone substations and Ausgrid’s Epping and Hunter’s Hill zone substations. Between them, Carlingford Transmission Substation currently supplies over 62,900 customers with a mix of 62% residential, 35% commercial and 3% industrial in the local government areas of City of Parramatta, The Hills Shire, Ryde City Council and the Municipality of Hunter's Hill.

The location of Carlingford Transmission Substation and the area that it serves is shown in Figure 2 below.

Figure 2 - Carlingford Transmission Substation supply area



The substation also provides the sole supply to major industrial / commercial customers NorthConnex Tunnel, Mitsubishi Electric and Rheem, as well as 1,660 residential customers with life support systems. Currently our customer’s value unserved energy from the Carlingford Transmission Substation at $3.79 million per hour.

The 62,900 customers served by Carlingford Transmission Substation use a total of 225 MVA of electricity during the peak summer evening periods and have an average year-round demand of 113 MVA and an annual energy usage of 990 gigawatt hours.

From a network perspective, Carlingford Transmission Substation is normally supplied at 132kV via feeders 930 and 931 from Sydney West Bulk Supply Substation via Blacktown and Baulkham Hills transmission substations. A further two 132kV feeders 926 and 927 inter-connect with Ausgrid's 132kV network.

4.2 Description of the need

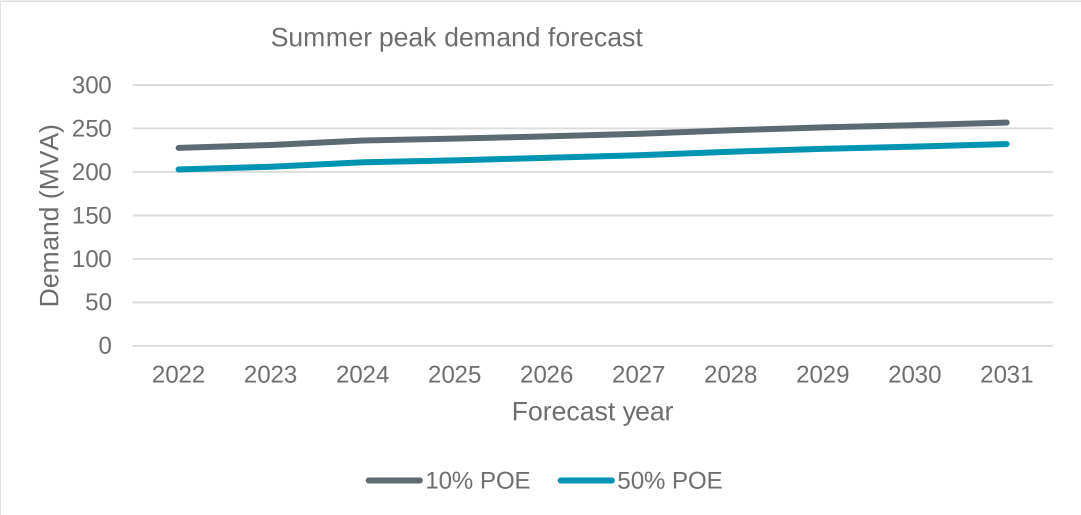
The need is that the roof of the control building is in poor condition with significant water leaks and a high and increasing risk of major failure. A roof failure is likely to cause damage to the protection and control systems which is likely to result in an inadvertent trip of the 132kV or 66kV busbars, feeders or transformers, resulting in the loss of supply from the substation for an extended period of time.

A further issue is the presence of asbestos throughout the control building. Although this issue is being managed, the asbestos presents a safety risk to personnel working in and around the building and to the public in the streets around the substation and in the high school which is adjacent the control building.

4.3 Load and energy at risk review

Figure 3 below shows our forecast peak summer load demand expected on Carlingford Transmission Substation over the next 10 years with a 10% probability of being exceeded and a 50% probability of being exceeded.

Figure 3 – Carlingford Transmission Substation demand forecast, 2022-2031



The load duration curve for Carlingford Transmission Substation throughout the year is shown in Figure 4 below and the load profile for a typical peak summer day is shown in Figure 5.

Figure 4 – The load duration curve for Carlingford Transmission Substation

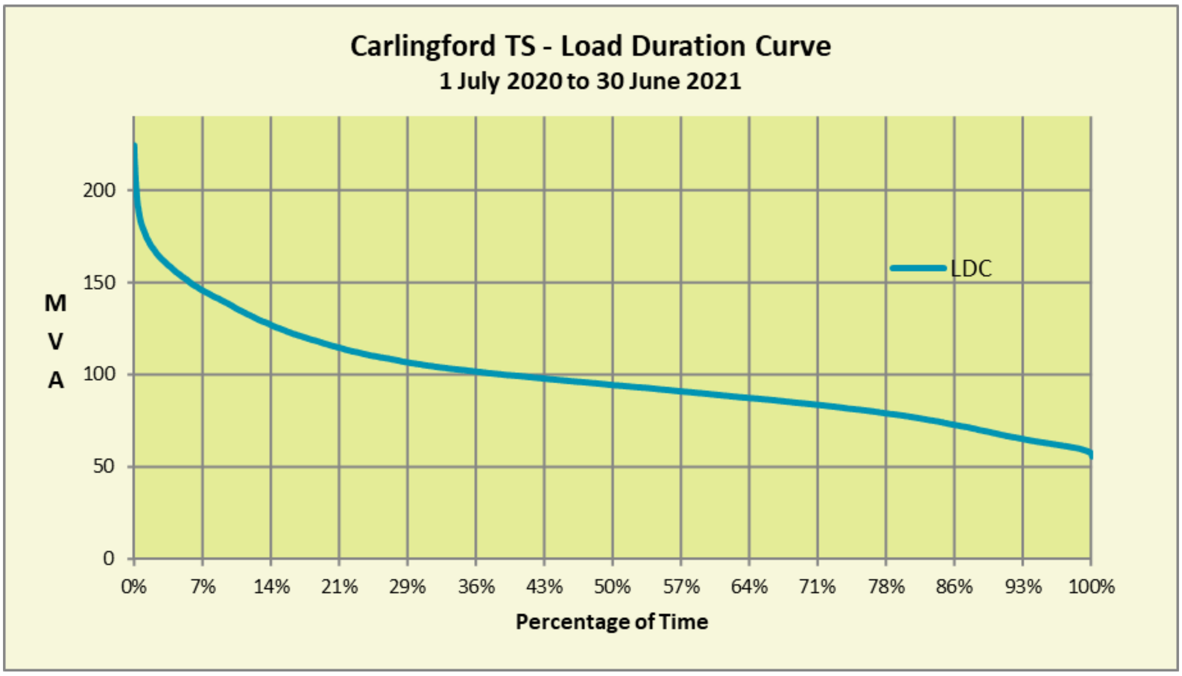
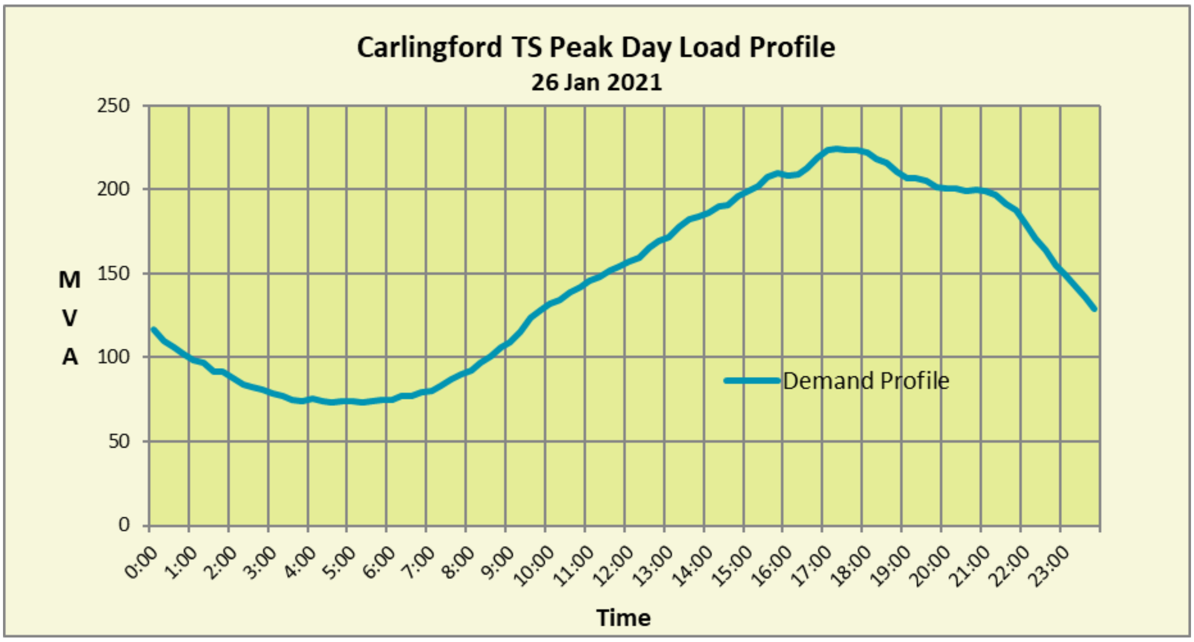


Figure 5 – Peak summer day profile for Carlingford Transmission Substation



4.4 Existing network

Carlingford Transmission Substation provides supply to the 62,900 customers it services through 10 x 66kV lines to six zone substations. The electricity is then distributed from each of the zone substations at 11kV. Two 66kV lines supply each zone substation in an essentially radial manner without any interconnection between these lines and other Transmission Substations, which operate at different voltages. Therefore, the only backup supply available to these customers on loss of the supply from Carlingford Transmission Substation is through the 11kV network from adjacent zone substations supplied from another transmission substation. Due to the location of Carlingford Transmission Substation on the eastern edge of Endeavour Energy's network and the topology of the network, this transfer capacity is limited to 10MVA (to Endeavour Energy's zone substations) during the peak demand periods and around 20MVA on average throughout the year.

This existing back-up supply capacity has been included in our assessment of the identified need.

5. Assumptions used in identifying the need

The assessment of this project is based on the RIT-D and the RIT-D application guidelines.

A baseline risk position has been established on the basis of a 'business as usual" counterfactual option. This option involves nil planned capital expenditure but will incur ongoing safety and reliability/unserved energy risks. This option will also involve future capital expenditure that will be required in a reactive manner to address the failed assets as a result of the lack of short-term capital investment.

Based on the asbestos related safety risks and the probability of failure of the control building roof structure with subsequent risk of loss of supply from the substation, the risk presented by the substation control building has been assessed as currently being $5.6 million per year with a present value over a 50-year assessment period of $123 million.

Given this level of risk, it has been identified that the control building at Carlingford Transmission Substation should be retired in order to manage the risk it presents.

The project explores different options to refurbish or replace the existing control building to maintain the service it provides and to defer and reduce the risks it presents.

6. Options considered

The credible network options to address the need at Carlingford Transmission Substation include:

1. Refurbishment of the control building roof and removal of the asbestos contamination; and
2. Replacement of the control building with a new building and subsequent demolition and removal of the existing building.

6.1 Option 1 – Refurbish the existing control building

This option includes the provision of a new roof and ongoing protection for the steel structure of the building. This option will effectively defer the unserved energy risks presented by the collapse of the building due to structural damage or the failure of the roof due to water ingress for around 50 years.

The refurbishment works will also include stripping out the asbestos from all accessible parts of the building and permanently sealing in the asbestos containing materials which cannot be practically removed. The protection and control equipment will also be relocated within the refurbished control building to eliminate the asbestos risks associated with the existing control panels.

This work will effectively eliminate the asbestos risks to the public and to workers once the works are complete and defer the reliability risk due to failure of the control building roof or structure.

The estimated cost of Option 1 is $7.20 million in real FY22 terms.

6.2 Option 2 – Replace the existing control building with a new building

Option 2 includes the replacement of the existing control building with a new compact building with new protection and control equipment and the demolition and removal of the existing control building.

The cost of Option 2 is estimated to be $11.3 million.

6.3 Options not considered

As highlighted in the screening report, it is not considered feasible that a non-network solution will form a potential credible option on a standalone basis, or form a significant part of a potential credible option for the Carlingford Transmission Substation RIT-D. This is due to the extent of the load at risk as a result of potential failure of the control building and the relatively low cost of network options compared to the high cost of non-network supply solutions for the magnitudes of demand and energy involved and the lack of capacity for the network to facilitate non-network technologies.

Refer to Section 4 of the Screening Report for further detail.

7. Modelling and assumptions

7.1 Market benefits

The RIT-D states that the preferred option is the credible option that maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the NEM.

The market benefit of a credible option is calculated by comparing the state of the world with the credible option in place with the state for the counterfactual case.

Endeavour Energy considers that the only relevant category of market benefits prescribed under the NER for this RIT-D relate to changes in involuntary load shedding.

Involuntary load shedding occurs when a customer's load is interrupted from the network without their agreement or prior warning. In this instance, this would occur if the control building roof at Carlingford TS leaked water or collapsed onto the protection equipment causing the inadvertent trip of some or all of the 132kV elements (busbars, transformers and lines) in the substation.

Endeavour Energy has forecast the load on the substation over the assessment period and has quantified the expected value of unserved energy by comparing the forecast load to the network capabilities under system normal and substation outage conditions. A reduction in involuntary load shedding expected from a credible option, relative to the base case, results in a positive contribution to market benefits of the option being assessed.

The value of involuntary load shedding associated with a credible option is derived from the quantity of load likely to be lost (in MWh) under that option multiplied by the Value of Customer Reliability (VCR), where VCR is measured in dollars per MWh and is used as proxy to evaluate the economic impact of unserved energy on customers under the RIT-D.

Endeavour Energy has applied an estimate of VCR of $31,300/MWh based on the VCR estimates provided by the AER in 2019, escalated to FY22 values using the annual CPI increase and weighted according to the make-up of the customers served by Carlingford Transmission Substation, which is a mixture of residential, commercial and industrial loads.

We have also investigated the effect of assuming both a lower and higher underlying VCR estimate of +/- 30% consistent with the stated level of confidence.

This assessment gives a range of VCR values from $21,000/MWh to $40,700/MWh.

7.2 Other benefits

Further benefits provided by the credible network options which have been included in the cost-benefit assessment include:

- A reduction in the safety risk to the public and to workers by the removal of the asbestos dust contamination from the control building and equipment in the building;

- A reduction in the financial risk costs associated with the perception of risk associated with exposure to asbestos; and
- A reduction in the reactive capital investment (financial risk) which would be required should the assets be allowed to fail.

The safety risk assessment considers the likelihood of persons being exposed to asbestos dust and the likelihood of a fatality occurring due to lung disease as a result of the exposure. A value of statistical life of $4.90 million has been assigned based on the value published by the Australian Government in 2014 escalated to FY22. Likelihood of consequences have been assessed based on the number of persons frequenting the public areas around the control building and electricity workers carrying out duties within the control building and estimates of the likelihood of exposure to asbestos fibres and contraction of lung disease as a result.

There are also financial risk costs associated with the perception of risk associated with exposure to asbestos which have been included in the cost-benefit assessment.

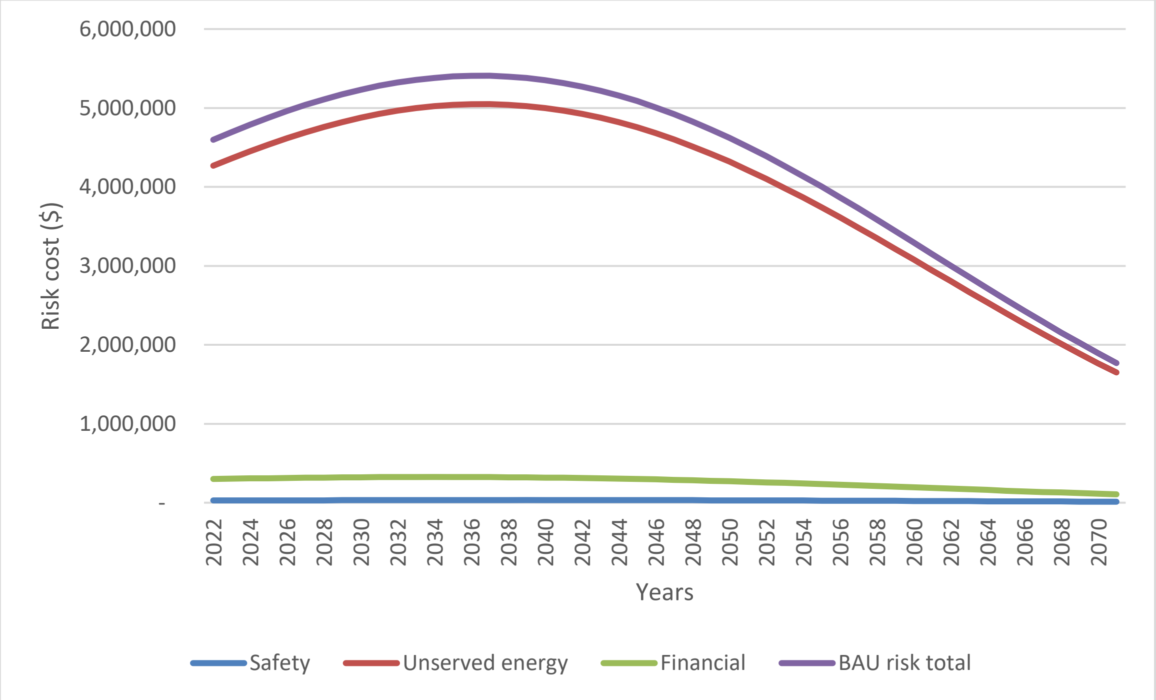
The magnitude of the risks associated with the business as usual case are summarised in Table 2 below.

Table 2 – Business as usual risk cost summary

Risk category	PV of risk ($M)	Risk proportion (%)
Safety	0.8	1
Unserved energy	115	93
Financial	1.7	1
Reactive capital cost	5.8	5
Total risk costs	**123**	**100**

Figure 6 below shows the assessed business as usual risk cost over the next 50 years.

Figure 6 – Business as usual risk



7.3 Project costs

The capital costs associated with each credible option noted above have been estimated based on the scope of works proposed and costing experience from previous projects of a similar nature recently completed.

7.4 Scenarios modelled to address uncertainty

RIT-D assessments are required to be based on a cost-benefit analysis that includes an assessment of 'reasonable scenarios', which are designed to test alternate sets of key assumptions and whether they affect identification of the preferred option.

Endeavour Energy has elected to assess three alternative future scenarios the central scenario including benefits and costs as estimated as reasonable and a low benefit/high cost boundary scenario and a high benefit/low cost boundary scenario.

The low benefit scenario uses conservative assumptions that give rise to a lower bound NPV estimate for each credible option, in order to represent a conservative future state of the world with respect to potential benefits that could be realised under each credible option.

The high benefit scenario uses an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected potential benefits.

Table 3 – Scenarios modelled

Variable	Scenario 1 – central values	Scenario 2 – low benefits/high costs	Scenario 3 – high benefits/low costs
Capital cost	Estimated capital costs	25% increase in the estimated capital costs	25% decrease in the estimated capital costs
Safety risk	Estimated network safety risk cost	30% decrease in the estimated safety risk costs	30% increase in the estimated safety risk costs
Value of customer reliability (VCR)	$31,300/MWh	$21,000/MWh (30% decrease in the central value)	$40,700/MWh (30% increase in the central value)
Financial risk	Estimated financial risk cost	30% decrease in the estimated financial risk costs	30% increase in the estimated financial risk costs
Discount rate	3.26% (WACC)	4.30% (30% increase in WACC)	2.22% (30% decrease in WACC)
Scenario weighting	33.3%	33.3%	33.3%

7.5 Results of Analysis

This section summarises the results of the NPV analysis, including the sensitivity analysis undertaken which compares the two credible options to the 'business as usual' counterfactual case. The assessment period is 50 years which is commensurate with the life extension likely to be provided to the control building by the proposed network options.

Benefits estimated for each credible option

Table 4 below summarises the benefit of each credible option relative to the base case in present value terms. As outlined above, the benefits are attributable principally to reduced involuntary load shedding with a small percentage due to reduced safety risks and reduced financial risks.

Table 4 – Present value of the expected benefits ($ FY22)

Option	Scenario 1– central values ($M)	Scenario 2 – low benefits/high costs ($M)	Scenario 3 – high benefits/low costs ($M)
Option 1	101.8	58.3	156.5
Option 2	101.3	58.1	155.9

Costs estimated for each credible option

Table 5 below summarises the cost of each credible option in present value terms.

Table 5 – Present value of the option costs ($ FY22)

Option	Scenario 1– central values ($M)	Scenario 2 – low benefits/high costs ($M)	Scenario 3 – high benefits/low costs ($M)
Option 1	6.87	8.46	5.23
Option 2	10.61	13.00	8.12

Net present value assessment outcomes

Table 6 below summarises the net benefits in present value terms for each credible option under each scenario. The net benefit is the gross benefit (as outlined in Table 4) less the cost of each option (as outlined in Table 4).

Due to the high levels of unserved energy avoided by these options, both options provide a strongly positive NPV for the boundary scenarios modelled, indicating that the economic assessment is robust.

Table 6 – Net present value of expected economic benefits ($M FY22)

Option	Scenario 1	Scenario 2	Scenario 3	Weighted	Option ranking
Option 1	94.9	49.9	151.3	98.6	1
Option 2	90.7	45.1	147.8	94.4	2

8. Selected option

Option 1 provides a significant reduction in unserved energy risk and eliminates the safety risk to the public and electricity workers due to the asbestos so far as is reasonably practicable (SFAIRP).

Option 2 provides similar but marginally reduced benefits compared to Option 1 due to the longer timeframe required to implement the option and hence the delay in realising the benefits. Option 2 is also significantly more costly than Option 1 and as a result, provides reduced value compared to Option 1.

On this basis, Option 1 is confirmed as being the preferred option, which satisfies the RIT-D.

This option is expected to cost $7.20 million and includes the replacement of the roof of the control building, the removal of asbestos contamination and the relocation and replacement of the protection and control equipment within the control building.

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